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(54) **Electro-therapy apparatus**

(57) Electro-therapy apparatus delivers modulated or mixed electromagnetic signal to a patient via electrodes A, B of substantially different sizes, so that the small electrode B provides a targeted and specific therapeutic effect. Typically the effect may be of pain relief. Two high frequency signals f_1 and f_2 may be mixed to deliver a signal having a beat frequency ($f_2 - f_1$) of 1 to 250 Hz, and the area of the electrode B at the treatment site may be over 50 times smaller than the other electrode A. The signal may be switched between a plurality of electrodes (B1 to B4).

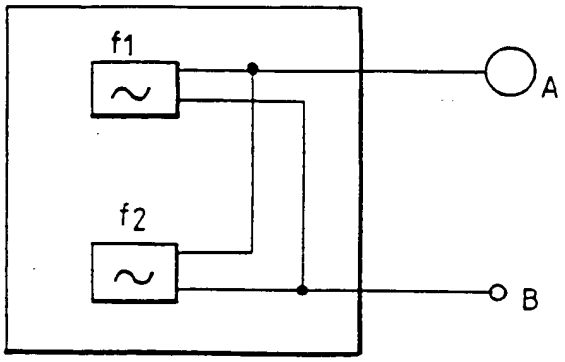

Fig. 3.

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At least one drawing originally filed was informal and the copy reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1990.

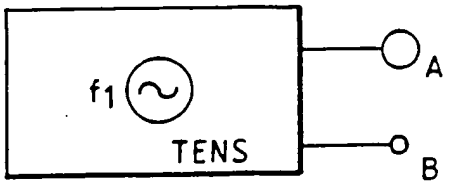

Fig.1.

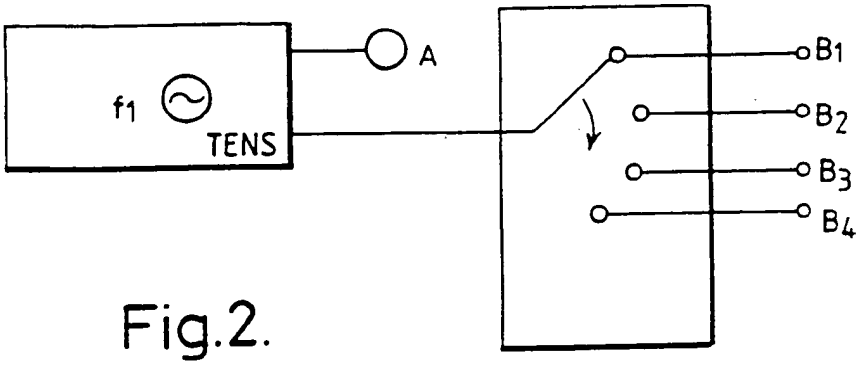

Fig.2.

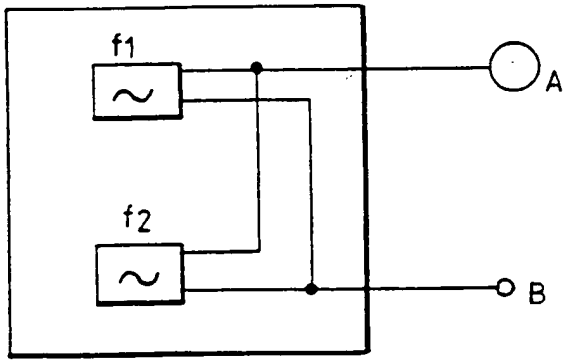

Fig.3.

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ELECTRO-THERAPY APPARATUS

This invention concerns electro-therapy apparatus, particularly, though by no means exclusively, anaesthetising apparatus capable of application for relief of pain arising from a temporary or chronic condition or during surgery.

It is well known that application of current at frequencies up to about 250 Hz is efficacious in relieving pain. Current at these frequencies tends to flow between surface electrodes in the epidermal surface with little or no penetration of the underlying tissues. This technique is known as TENS or transcutaneous nerve stimulation.

Penetration of the underlying tissues can be achieved by modulation in the apparatus of a high frequency signal with a low frequency (up to 250 Hz) signal, or by mixing respective higher frequency oscillating or pulsing electric currents, which differ in frequency by up to about 250 Hz, and delivering the modulated or mixed signal to the patient.

In such techniques the electrodes are of the same area as each other. I have found that substantial benefits may be achieved by using electrodes of differing areas.

According to the present invention there is provided electro-therapy apparatus as described above, having at least one feed electrode adapted to feed an oscillating or pulsing electric current to a patient at a selected feed site or sites on or beneath an epidermal or mucous surface and at least one return electrode adapted to be positioned on or beneath an epidermal or mucous surface, characterised in that the area of the feed electrode effective to provide a signal to a patient or the summated

area of the feed electrodes effective to provide a signal or signals to a patient, when there is more than one feed electrode (with reference to these operational at a given moment, when sequential switching thereof is employed) - hereinafter called the "feed area" - exceeds by a factor of more than 2 the area of the return electrode effective to receive a signal or signals from the feed electrode or electrodes via the patient, or the summated area of the return electrodes effective to receive a signal from the feed electrode or electrodes, via the patient, when there is more than one return electrode (with reference to those operational at any given moment, when sequential switching thereof is employed) - hereinafter called the "return area".

Although the apparatus of the present invention may be adapted for penetrative or invasive operation, preferred apparatus of the invention is adapted for non-penetrative or non-invasive operation. Thus, the feed electrode(s) may suitably be adapted to feed respective oscillating or pulsing electric current(s) to the selected feed site(s) on the epidermal or mucous surface, and the return electrode(s) may also be adapted to be positioned on an epidermal or mucous surface, local to the treatment site(s).

Suitable oscillating or pulsing electric current(s) may be effectively pulsed d.c. current(s), that is, with only a positive (or negative) voltage in a cycle. The current(s) may alternatively be alternating current(s), that is current(s) with positive and negative voltages in the cycle. The wave form(s) is/are not believed to be critical, though square wave, sawtooth and, especially, sinusoidal forms are preferred.

As indicated above, there may be a plurality of feed and/or return electrodes. There may suitably be means for switching the electrodes into circuit sequentially. Suitably, there may be a single feed electrode and a plurality of such return electrodes, and means for switching the return electrodes into circuit sequentially.

Preferably, the apparatus provides a signal at a frequency in the range about 60 to about 150 Hz and preferably at or about 80 or 130 Hz. When such a signal is provided by modulation in the apparatus of a higher frequency signal or mixing in the apparatus of higher frequency signals which are different in frequency from each other, the higher frequency signal or signals may for example exceed about 1 KHz, preferably exceeding about 3 KHz. Contact or capacitative feed electrode(s) may be employed. Contact feed electrode(s) when employed preferably supply current at a frequency in the range of about 4 to 20 KHz. Capacitative feed electrode(s) when employed may desirably supply current at much higher frequencies.

The feed electrode(s) may be adapted to supply signal(s) at a varying frequency. This may be effected automatically, by "sweeping" the frequency. It may be under the control of the patient, who may vary one or more frequencies to provide the perceived optimal therapeutic effect.

Suitably, "feed area" exceeds the "return area" by a factor of at least 4.

Suitably, the "feed area" exceeds the "return area" by a factor of at least 10.

Suitably, the "feed area" exceeds the "return area" by a factor of at least 20.

Suitably, the "feed area" exceeds the "return area" by a factor of at least 50.

A return electrode is preferably a contact electrode, to provide accurate targeting, and may be in the form of a disc, band, probe, micropipette, needlepoint or any other form appropriate to the type of electro-therapy which it is desired to provide and/or the medical context.

The invention will now be further described with reference to the accompanying drawings, which show, by way of example only, several forms of electro-therapy apparatus.

Of the drawings:-

Figure 1 shows a diagrammatic representation of a first form of TENS-type apparatus;
Figure 2 shows a diagrammatic representation of a second form of TENS-type apparatus; and
Figure 3 shows a diagrammatic representation of a third form of apparatus in which a modulated signal is supplied.

Referring firstly to Figure 1, it will be seen that a single electrical oscillator (alternatively a pulsed D.C. supply) is connected to a single feed electrode A and a single return electrode B. The electrodes are contact electrodes adapted to be positioned on the epidermal surface in the region of the site to be treated. The oscillator oscillates with a frequency f_1 which may be in the range 1-200 Hz, and is under the control of the patient. The return electrode B has a smaller "return

area" than the "feed area" of the feed electrode A, by a factor of about 30. In this context it should be noted that the "return area" and the "feed area" are the areas of the electrodes which are actually in contact with the epidermal surface.

The apparatus of Fig. 2 is similar to that of Fig. 1, but there are a plurality of return contact electrodes B_1, B_2, B_3 and B_4, and they are brought into circuit sequentially, as indicated schematically. At any given instant the "return area" - the area in contact with the patient and which is then in circuit is smaller than the "feed area" by a factor of about 4.

The apparatus at Figure 2 could be useful, for example, for pain relief during childbirth with the return electrodes being located adjacent vertebrae L_3, L_4, S_1 and S_2 in the lumbar or curve region of the spine, with the feed electrode A located higher up on the patient's back. Alternatively, the apparatus could be useful for treatment of arthritis with the return electrodes being located adjacent to different arthritic joints.

Figure 3 shows an apparatus having two oscillators and in which high frequency signals f_1 and f_2 are superposed within the apparatus so that a modulated signal is provided between the large feed electrode A and the small return electrode B, which is to be located adjacent a treatment site. The "feed area" may be about 50 times greater than the "return area". In this embodiment, one oscillator might, for example, provide a signal of frequency f_1=12000 Hz, and the other oscillator, a signal of frequency f_2=12000 Hz ± 1 to 250 Hz, so that a beat frequency (f_2 - f_1) of 1 to 250 Hz is provided. The

electro-therapeutic effect will tend to be most marked in the region of the small return electrode B.

The oscillator(s) in all the examples provide currents up to about 120 mA at voltages up to about 120 V, and preferably at about 50 V. The wave forms of the currents and/or voltages are preferably sinusoidal.

Although these examples describe the use of contact electrodes capacitative electrodes could be used.

Although these examples describe the use of oscillators, pulsed D.C. supplies could be used.

It will be appreciated that it is not intended to limit the invention to the above example only, many variations, such as might readily occur to one skilled in the art, being possible, without departing from the scope thereof.

The invention has been described in the foregoing examples primarily in relation to the provision of anaesthesia, but there are expected to be various other ways in which the apparatus can be used, examples being in physiotherapy, where muscles may be stimulated, suitably by low frequency waves or beats, for example 5 to 20 Hz, and in electro-stimulative brain procedures, and in bone regeneration therapy.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. Electro-therapy apparatus as described herein, having at least one feed electrode adapted to feed an oscillating or pulsing electric current to a patient at a selected feed site or sites on or beneath an epidermal or mucous surface and at least one return electrode adapted to be positioned on or beneath an epidermal or mucous surface, characterised in that the area of the feed electrode effective to provide a signal to a patient or the summated area of the feed electrodes effective to provide a signal or signals to a patient, when there is more than one feed electrode (with reference to these operational at a given moment, when sequential switching thereof is employed) - the "feed area" - exceeds by a factor of more than 2 the area of the return electrode effective to receive a signal or signals from the feed electrode or electrodes via the patient, or the summated area of the return electrodes effective to receive a signal from the feed electrode or electrodes, via the patient, when there is more than one return electrode (with reference to those operational at any given moment, when sequential switching thereof is employed) - the "return area".

2. Electro-therapy apparatus as claimed in Claim 1, which is adapted for non-penetrative or non-invasive operation.

3. Electro-therapy apparatus as claimed in Claim 1 or 2, comprising a single feed electrode and a plurality of return electrodes, and means for switching the return electrodes into circuit sequentially.

4. Electro-therapy apparatus as claimed in any preceding claim, wherein the apparatus provides a signal at a frequency in the range about 60 to about 150 Hz.

5. Electro-therapy apparatus as claimed in any preceding claim, wherein the "feed area" exceeds the "return area" by a factor of at least 4.

6. Electro-therapy apparatus as claimed in Claim 5, wherein the "feed area" exceeds the "return area" by a factor of at least 20.

7. Electro-therapy apparatus substantially as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
9110283.0

Relevant Technical fields

(i) UK Cl (Edition K) A5R (RHAA)

(ii) Int Cl (Edition)

Search Examiner
R S CLARK

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search
17 AUGUST 1992

Documents considered relevant following a search in respect of claims ALL

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2228683 A (T MATHEWS) Whole document	1-7

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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P: Document published on or after the declared priority date but before the filing date of the present application.

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&: Member of the same patent family, corresponding document.

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